OREOS – OEO 1 AND OEO 6 BLACK OREO AND SMOOTH OREO

1. FISHERY SUMMARY

This is presented in the Fishery Summary section at the beginning of the Introduction – Oreos chapter.

2. BIOLOGY

This is presented in the Biology section at the beginning of the Introduction – Oreos chapter.

3. STOCKS AND AREAS

This is presented in the Stocks and Areas section at the beginning of the Introduction – Oreos chapter.

4. STOCK ASSESSMENT

4.1 Introduction

New assessments for Pukaki Rise black oreo and Pukaki Rise smooth oreo were attempted in 2013 but were rejected by the Working Group and are only briefly discussed here. The previously reported assessments for Southland (OEO 1/OEO 3A) and Bounty Plateau smooth oreo (only MPD results) are repeated.

4.2 Southland smooth oreo fishery

This assessment was updated in 2007 and applies only to the study area as defined in Figure 1 and does not include areas to the north (Waitaki) and east (Eastern canyon) of the main fishing grounds.

This fishery is mostly in OEO 1 off the east coast of the South Island but catches at the northern end of the fishery straddle and cross the boundary line between OEO 1 and OEO 3A at 46º S. This is an old fishery with catch and effort data available from 1977–78. Smooth oreo catch from Southland was about 480 t (mean of 2003–04 to 2005–06). There is an industry catch limit of 400 t smooth oreo which was implemented after the previous (2003) assessment. There were no fishery-independent abundance estimates, so relative abundance estimates from pre- and post-GPS (Global Positioning System) standardised CPUE analyses and length frequency data collected by Ministry (SOP) and industry (ORMC) observers were used.

The following assumptions were made in this analysis.

1. The CPUE analysis indexed the abundance of smooth oreo in the study area of OEO 1/3A.
2. The length frequency samples were representative of the population being fished.
3. The ranges used for the biological values covered their true values.
4. Recruitment was deterministic and followed a Beverton-Holt relationship with steepness of 0.75.
5. The population of smooth oreo in the study area was a discrete stock or production unit.
6. Catch overruns were 0% during the period of reported catch.
7. The catch histories were accurate.
8. The maximum fishing pressure (U_{MAX}) was 0.58.

An age-structured CASAL model employing Bayesian statistical techniques was developed. A two-fishery model was employed with a split into deep and shallow fisheries because of a strong relationship found between smaller fish in shallow water and large fish in deeper water. The boundary between deep and shallow was 975 m. The 2007 analysis used five extra years of catch and observer length frequency data compared with the 2003 assessment. The model was partitioned by the sex and maturity status of the fish and used population parameters previously estimated from fish sampled on the Chatham Rise

and Puysegur Bank fisheries. The maturity ogive used was estimated from Chatham Rise research samples.

4.2.1 Estimates of fishery parameters and abundance

Catch history

A catch history (Table 1) was derived using declared catches of OEO from OEO 1 (see table 2 in the Fishery Summary section at the beginning of the Introduction – Oreos chapter) and tow-by-tow records of catch from the study area (Figure 1). The tow-by-tow data were used to estimate the species ratio (SSO/BOE) and therefore the amount of SSO taken. It was assumed that the reported landings provided the best information on total catch quantity and that the tow-by-tow data provided the best information on the species and area breakdown of catch.

Table 1: Catch history of smooth oreo from Southland rounded to the nearest 10 t.

Fishing year	Shallow	Deep	Fishing year	Shallow	Deep
1977–78	210	0	1992–93	410	250
1978–79	10	0	1993–94	220	150
1979–80	40	0	1994–95	80	150
1980–81	0	0	1995–96	600	500
1981–82	0	0	1996–97	440	70
1982–83	0	0	1997–98	320	230
1983–84	480	660	1998–99	480	620
1984–85	170	510	1999–00	650	480
1985–86	480	3 760	2000–01	400	610
1986–87	30	160	2001–02	580	1 470
1987–88	130	860	2002–03	130	1 320
1988–89	0	240	2003–04	330	420
1989–90	210	430	2004–05	140	290
1990–91	410	420	2005–06	120	140
1991–92	530	380			

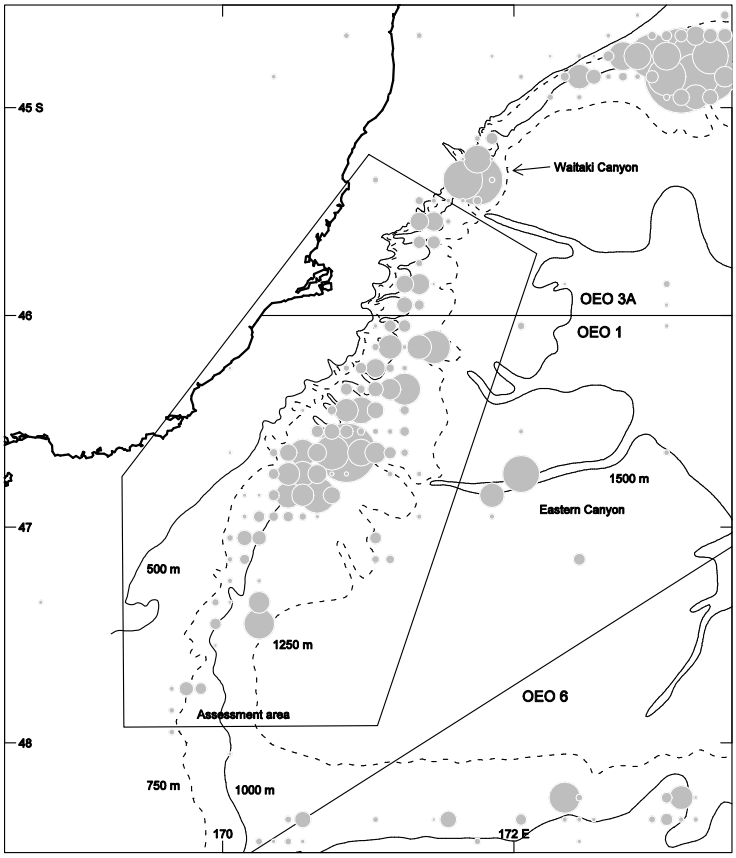


Figure 1: Smooth oreo estimated catch from all years up to (and including) 2005–06. The area was divided into cells that are 0.1 degrees square and catches were summed for each cell. Circles proportional in area to the catch are plotted centred on the cells. Catches less than 10 tonnes per cell are not shown. Circles are layered so that smaller circles are never hidden by larger ones. The assessment area and bottom topography are also shown.

Length data

All SOP records where smooth oreo were measured from within the assessment area are shown in Table 2: 78 samples were shallow and 51 were deep. Only 13 shallow and 4 deep samples were collected before 1999–2000 (Table 2). Composite length frequency distributions were calculated for each year. Each sample was weighted by the catch weight of the tow from which the sample was taken. This was modified slightly by estimating the number of fish that would be in a unit weight of catch and multiplying by that.

Table 2: Summary of length frequency data for smooth oreo available for the study area. Year group, year applied, and the total number of length frequency samples (lfs) for the shallow and deep year groups.

Year group	Year applied	No. of lfs
Shallow		
a=1993–94 to 1997–98	1995–96	13
b=1999–2000	1999–00	30
c=2000–01 to 2001–02	2001–02	22
d=2002–03 to 2005–06	2004–05	13
Deep		
e=1997–98 to 2001–02	2001–02	27
f=2002–03 to 2004–05	2003–04	21

Relative abundance estimates from CPUE analyses

The standardised CPUE analyses used a two part model which separately analysed the tows which caught smooth oreo using a log-linear regression (referred to as the positive catch regression) and a binomial part which used a Generalised Linear Model with a logit link for the proportion of successful tows (referred to as the zero catch regression). The binomial part used all the tows but considered only whether or not the species was caught and not the amount caught. The yearly indices from the two parts of the analysis (positive catch index and zero catch index) were multiplied together to give a combined index. The pre-GPS data for 1983–84 to 1987–88 have been left unmodified since 2003 and were used as an index of the deep fishery because most fishing in that period was deep (Table 3). The post-GPS data covered 1992–93 to 2005–06 split into shallow and deep fisheries, but the indices for the last two years (2004–05, 2005–06) were dropped because catch was constrained by the industry catch limit of 400 t for smooth oreo introduced after the 2003 assessment (Table 4).

Table 3: Smooth oreo pre-GPS combined index estimates by year, and jackknife CV estimates from analysis of all tows in the study area that targeted smooth oreo, black oreo, or unspecified oreo.

Fishing year	Combined index	Jackknife CV (%)
1983–84	1.75	22
1984–85	1.65	29
1985–86	1.19	33
1986–87	0.48	23
1987–88	0.61	27

Table 4: Smooth oreo post-GPS combined index estimates by year, and jackknife CV estimates from analysis of all tows in the study area that targeted smooth oreo, black oreo, or unspecified oreo.

	Shallow		Deep	
Fishing year	Index (kg/tow)	Bootstrap CV (%)	Index (kg/tow)	Bootstrap CV (%)
1992–93	1 489	57	1 401	73
1993–94	956	47	916	53
1994–95	1 521	72	428	121
1995–96	1 173	37	1 862	84
1996–97	511	84	2 117	41
1997–98	1 477	39	502	59
1998–99	939	42	915	50
1999–00	842	44	611	48
2000–01	758	46	385	72
2001–02	573	44	658	53
2002–03	303	48	406	76
2003–04	480	57	719	218

4.2.2 Biomass estimates

Biomass estimates were made based on a Markov chain Monte Carlo analysis which produced a total of about 1.4 million iterations. The first 100 000 iterations were discarded and every 1000th point was retained, giving a final converged chain of about 1300 points.

Biomass estimates for the base case are given in Table 5 and Figure 2. These biomass estimates are uncertain because of the reliance on commercial CPUE data for abundance indices.

Table 5: Biomass estimates (t) for the base case.

	5%	Median	Mean	95%	CV (%)
Free parameters					
Virgin mature biomass (B_0)	15 600	17 400	17 900	21 700	12
Selectivity, shallow a1	17.2	19.0	19.0	21.0	6
sL	3.9	4.8	4.8	5.8	12
sR	5.9	8.3	8.4	11.2	20
Selectivity, deep a50	22.1	26.0	26.2	30.8	10
to95	1.9	7.1	7.0	11.0	37
Derived quantities					
Current mature biomass (% initial)	19	27	28	41	25
Current selected shallow biomass (% initial)	56	65	65	73	8
Current selected deep biomass (% initial)	12	20	22	36	36

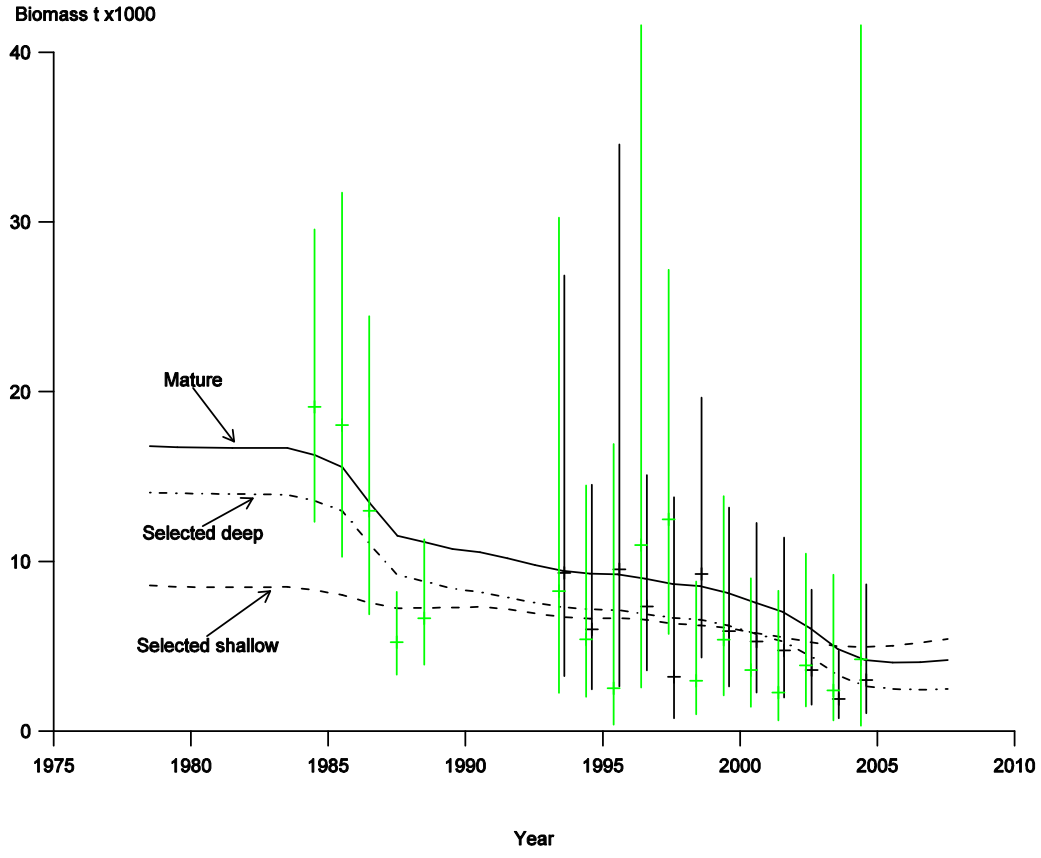


Figure 2: Estimated biomass trajectories from the 2007 base case assessment — mature biomass and selected biomass for the shallow and deep fisheries. Also shown are the CPUE indices from the pre- and post-GPS analysis for the deep fishery (in green) and the post-GPS analyses for the shallow fishery (in black). CPUE indices are shown with ±2 s.e. confidence interval indicated by the vertical lines (the post-GPS CPUE data are slightly offset to avoid over plotting). The CPUE data were scaled by catchability coefficients to match the biomass scale.

4.3 Pukaki Rise smooth oreo fishery (part of OEO 6)

A second assessment for this fishery was attempted in 2013, applying only to the assessment area as defined in Figure 3. The first assessment for this fishery was in 2006–07 (Coburn et al 2007, McKenzie

2007). This is the main smooth oreo fishery in OEO 6 with an annual catch in 2011–12 of 290 t, taken mainly by New Zealand vessels, down substantially from previous years (Table 6). There was also a small early Soviet fishery (1980–81 to 1985–86) with mean annual catches of less than 100 t. There were no fishery-independent abundance estimates, so relative abundance estimates from a post-GPS standardised CPUE analysis and length frequency data collected by Ministry and industry observers were considered. Biological parameter values estimated for Chatham Rise and Puysegur Bank smooth oreo were used in the assessment because there are no research data from Pukaki Rise. However, the CPUE analysis was not accepted as an index of abundance for smooth oreo in the Pukaki Rise (OEO 6) assessment area, principally due to the complex temporal and spatial patterns of this fishery and associated fisheries, and the small number of vessels. As a result, the assessment was not accepted by the Working Group, and only catch history, length frequency distributions, and unstandardised catch and effort data are reported here.

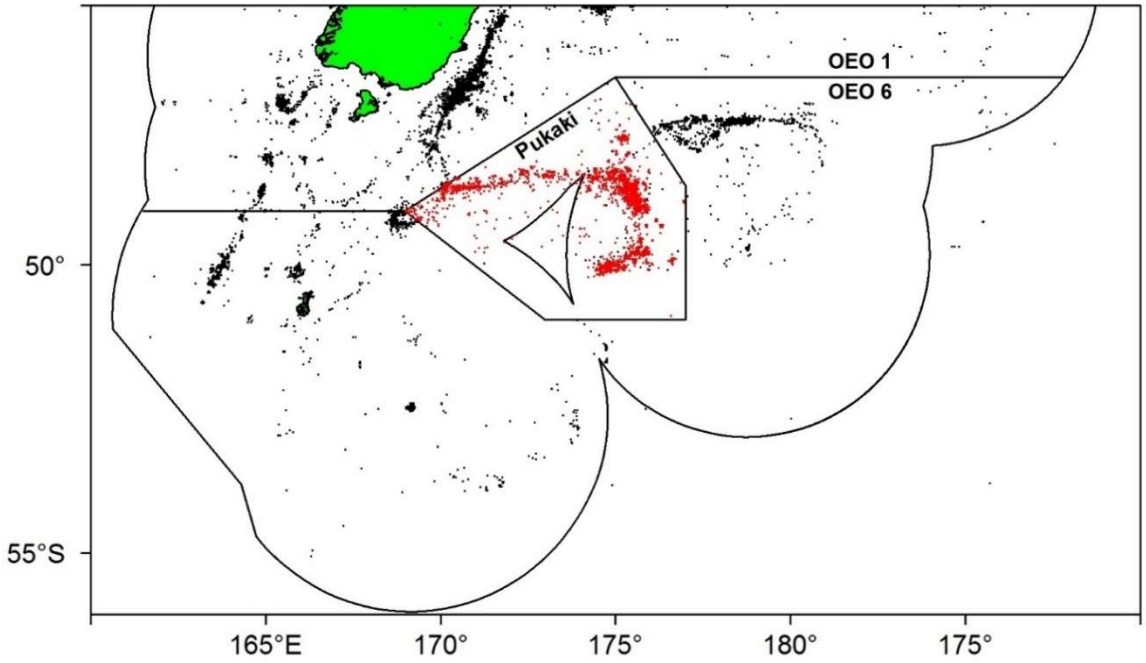


Figure 3: The Pukaki Rise fishery assessment area (polygon) abutting the north boundary of OEO 6. The dots show all tows where the target species or catch was OEO, SSO, BOE, or ORH, with the red dots being those within the Pukaki assessment area.

Table 6: Catch history of smooth oreo from the Pukaki Rise fishery assessment area. Catches are rounded to the nearest 10 t.

Year	Catch	Year	Catch	Year	Catch	Year	Catch
1980–81	30	1988–89	0	1996–97	1 650	2004–05	1 370
1981–82	20	1989–90	0	1997–98	1 340	2005–06	1 470
1982–83	0	1990–91	10	1998–99	1 370	2006–07	1 790
1983–84	640	1991–92	0	1999–00	2 270	2007–08	1 260
1984–85	340	1992–93	70	2000–01	2 580	2008–09	1 200
1985–86	10	1993–94	0	2001–02	2 020	2009–10	770
1986–87	0	1994–95	130	2002–03	1 340	2010–11	820
1987–88	180	1995–96	1 360	2003–04	1 660	2011–12	290
						2012–13	136

4.3.1 Estimates of fishery parameters and abundance

Catch history

A catch history was derived using declared catches of OEO from OEO 6 (table 2 in the Fishery Summary section of the Introduction – Oreos chapter) and tow-by-tow records of catch from the assessment area (Figure 3). The tow-by-tow data were used to estimate the species ratio (SSO/BOE) and therefore the amount of SSO taken. It was assumed that the reported landings provided the best information on total catch quantity and that the tow-by-tow data provided the best information on the species and area breakdown of catch. There may be unreported catch from before records started, though this is thought to be small. Before the 1983–84 fishing year the species catch data were

combined over years to get an average figure that was then applied in each of those early years. For the years from 1983–84 onwards, each year's calculation was made independently. The catch history used in the population model is given in Table 6.

Length data

Smooth oreo length frequency data collected by observers are available for the years 1997–98 to 2011–12 (Table 7). An in-depth analysis of these data in the previous assessment (covering fishing years 1998–2005) indicated that they were reasonably representative of the fishery in terms of spatial, depth, and temporal coverage in those years that had adequate data (Coburn et al 2007). The depths fished by the sampled fleet varied between years, so the length data were stratified by depth resulting in shallow (less than 900 m), middle (900–990 m), and deep strata (greater than 990 m). The data from adjacent years were also grouped because some years had few samples. The resulting length frequency distributions are shown in Figure 4.

Table 7: Summary of length frequency data for smooth oreo available for the assessment area. The table shows the number of tows sampled by year, the sample source, and the year group. –, no data.

		Number of tows sampled		
Year	**Year group**	**ORMC**	**SOP**	**All**
1997–98	98–99	–	15	15
1998–99	98–99	64	9	73
1999–00	00–01	5	36	41
2000–01	00–01	37	17	54
2001–02	01–02	42	22	64
2002–03	03–04	4	12	16
2003–04	03–04	–	19	19
2004–05	05–06	–	30	30
2005–06	05–06	–	20	20
2006–07	06–07	–	205	205
2007–08	07–08	–	124	124
2008–09	08–09	–	66	66
2009–10	09–10	–	46	46
2010–11	10–11	–	107	107
2011–12	10–11	–	21	21
Totals		152	149	301

Catch and effort data

Core vessels for the fishery were defined to develop a standardised CPUE series, but the standardised series was rejected by the Working Group. Unstandardised catch and effort data are presented in Table 8.

Table 8: Catch and effort data for vessels with three or more consecutive fishing years with at least 10 records from 1995–96 (1996) to 2011–12 (2012).

Fishing year	No. of tows	No. of vessels	Estimated catch (t)	Mean t/tow	Zero catch tows (%)	SSO target (%)
1996	193	2	810	4.20	-	6
1997	322	3	1 270	3.90	4	4
1998	264	4	1 020	3.90	6	9
1999	262	4	1 050	4	1	15
2000	528	5	2 030	3.90	32	37
2001	588	7	2 280	3.90	49	52
2002	409	5	1 920	4.70	9	9
2003	498	5	1 230	2.50	14	18
2004	512	4	1 300	2.50	9	13
2005	588	6	1 170	2	21	27
2006	656	5	1 260	1.90	13	14
2007	806	5	1 550	1.90	23	25
2008	933	2	1 110	1.20	13	16
2009	918	3	1 200	1.30	21	23
2010	948	3	740	0.80	8	11
2011	593	3	720	1.20	22	25
2012	397	2	260	0.70	10	12

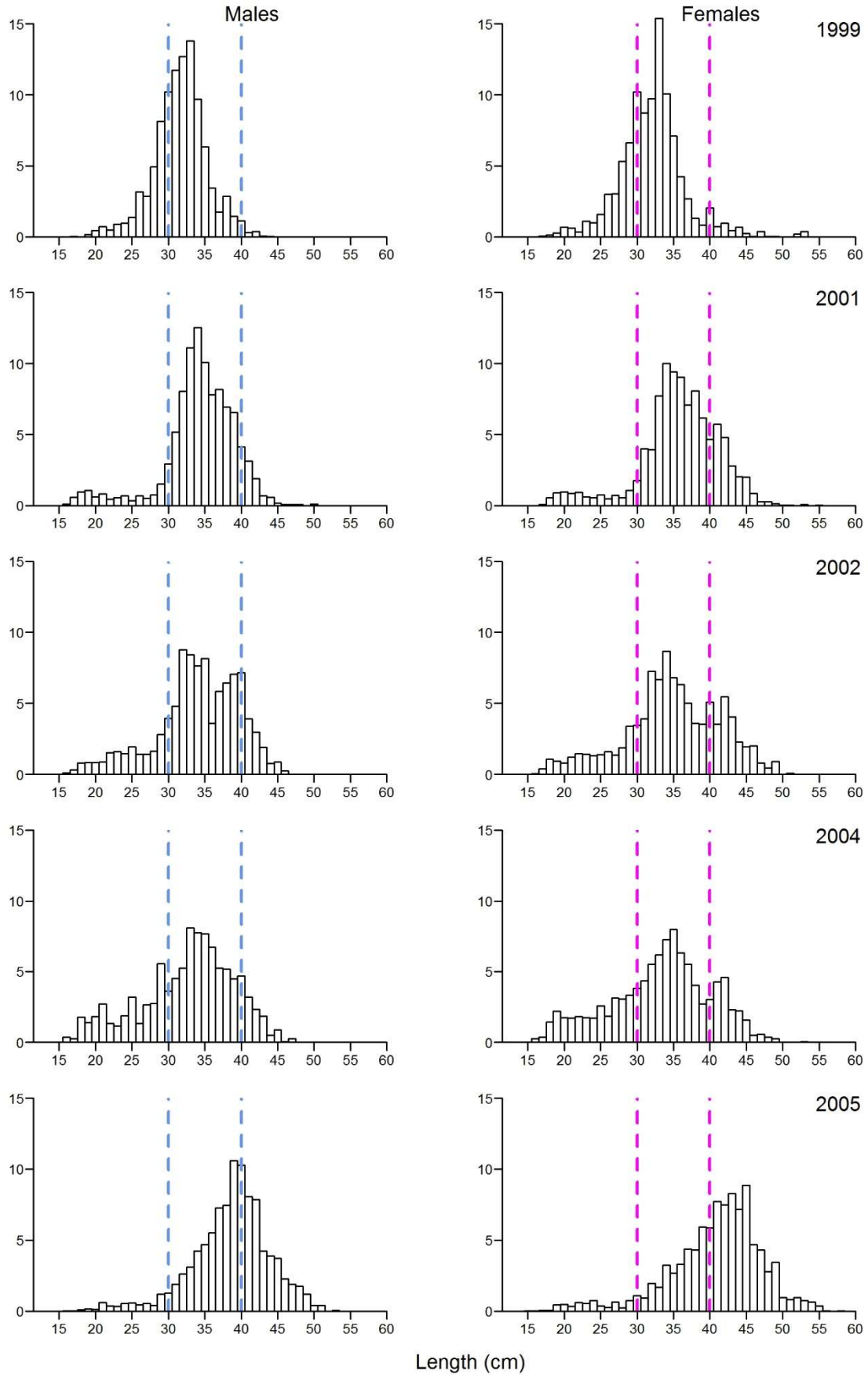


Figure 4: Length frequencies for Pukaki Rise smooth oreo, stratified by depth (see text), and grouped by years. **[Continued on next page]**

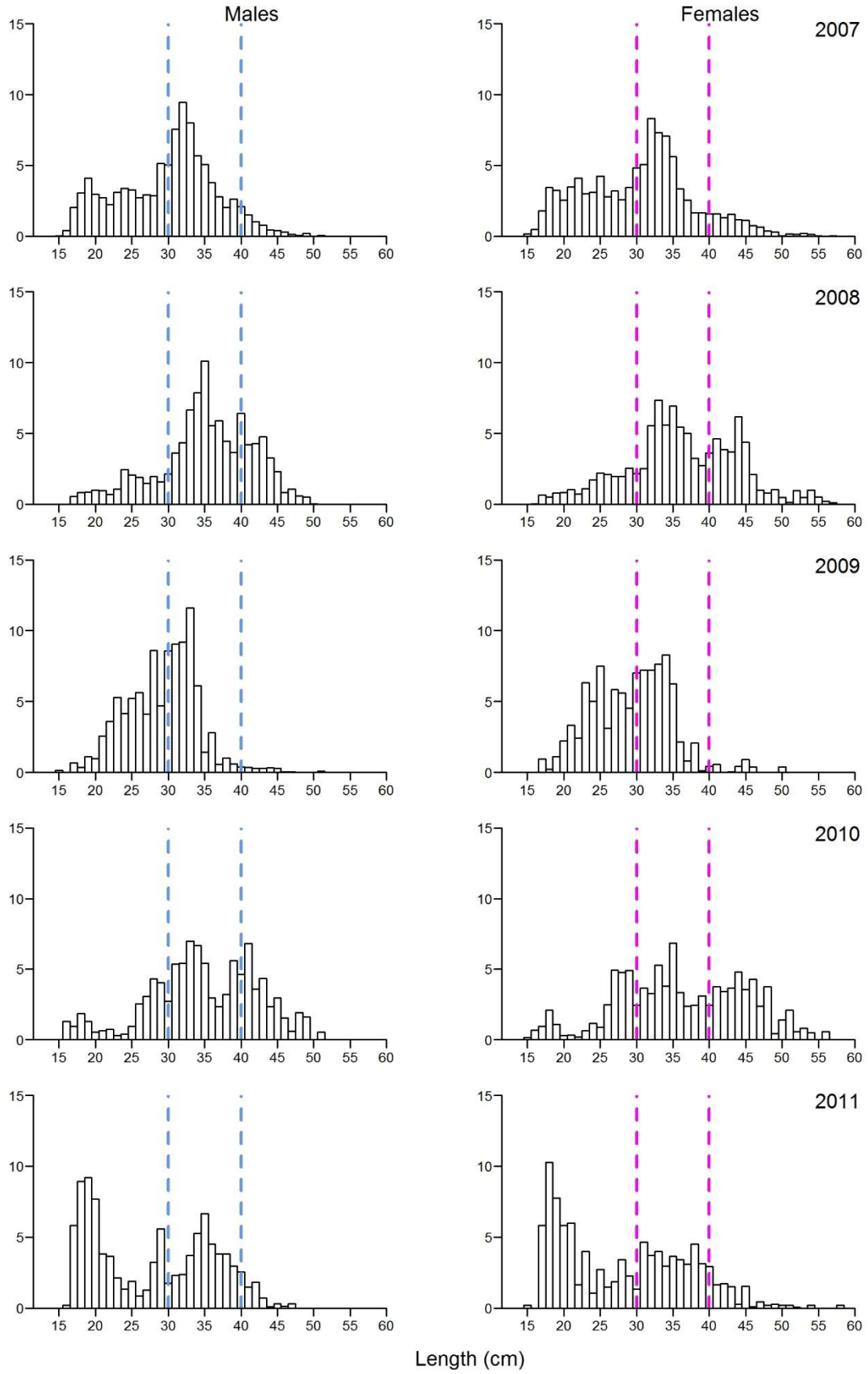


Figure 4: [Continued].

4.4 Bounty Plateau smooth oreo fishery (part of OEO 6)

The first assessment for this fishery was developed in 2008 and applies only to the study area as defined in Figure 5. There were no fishery-independent abundance estimates, so relative abundance estimates from a post-GPS standardised CPUE analysis and length frequency data collected by Ministry (SOP) and industry (ORMC) observers were considered. Biological parameter values estimated for Chatham Rise and Puysegur Bank smooth oreo were used in the assessment because there are no research data from Bounty Plateau.

The following assumptions were made in this analysis.

1. The CPUE analysis indexed the abundance of smooth oreo in the Bounty Plateau (OEO 6) assessment area.
2. The length frequency samples were representative of the population being fished.
3. The biological parameters values used (from other assessment areas) are close to the true values.
4. Recruitment was deterministic and followed a Beverton & Holt relationship with steepness of 0.75.
5. The population of smooth oreo in the assessment area was a discrete stock or production unit.
6. Catch overruns were 0% during the period of reported catch.
7. The catch histories were accurate.
8. The maximum exploitation rate (E_{MAX}) was 0.58.

Data inputs included catch history, relative abundance estimates from a standardised CPUE analysis, and length data from SOP and ORMC observers. The observational data were incorporated into an age-based Bayesian stock assessment (CASAL) with deterministic recruitment to estimate stock size. The stock was considered to reside in a single area, with a partition by sex. Age groups were 1–70 years, with a plus group of 70+ years.

The length-weight and length-at-age population parameters are from fish sampled on the Chatham Rise and Puysegur Bank fisheries (table 1 of the Biology section of the Introduction – Oreos chapter). The natural mortality estimate is based on fish sampled from the Puysegur Bank fishery. The maturity ogive is from fish sampled on the Chatham Rise, and the age at which 50% are mature is between 18 and 19 years for males and between 25 and 26 years for females.

4.4.1 Estimates of fishery parameters and abundance

Catch history

Table 9: Catch history (t) of smooth oreo from the Bounty Plateau fishery assessment area. Catches are rounded to the nearest 10 t.

Fishing year	Catch	Fishing year	Catch
1983–84	620	1996–97	610
1984–85	0	1997–98	650
1985–86	0	1998–99	1 200
1986–87	0	1999–00	870
1987–88	10	2000–01	550
1988–89	0	2001–02	980
1989–90	0	2002–03	1 530
1990–91	20	2003–04	1 420
1991–92	0	2004–05	2 190
1992–93	110	2005–06	1 790
1993–94	490	2006–07	670
1994–95	1 450	2007–08	670
1995–96	900		

A catch history was derived using declared catches of oreo from OEO 6 (table 2 in the Fishery Summary section of the Introduction – Oreos chapter) and tow-by-tow records of catch from the assessment area (Figure 5). The tow-by-tow data were used to estimate the species ratio (SSO/BOE) and therefore the amount of SSO taken. The catch history used in the population model is given in Table 9.

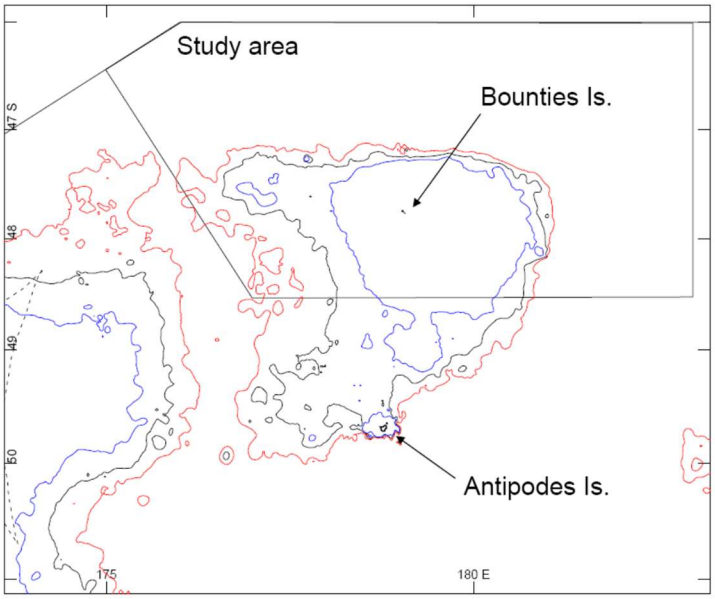


Figure 5: The Bounty Plateau fishery assessment study area.

Length data

Smooth oreo length frequency data collected by SOP and ORMC observers are available from 1991–92. An in-depth analysis indicated that these data were reasonably representative of the fishery in terms of spatial, depth, and temporal coverage in those years that had adequate data. Length frequencies were based on tows from the core area (a subset of the study area where about 80% of the catch is taken). The data from adjacent years were grouped because some years had few samples (Table 10). The resulting length frequency distributions are shown in Figure 6. In the final model runs the 1994–95 year of the length frequency series was omitted because it contained very few samples.

Table 10: Core length analysis year group, year applied and the number of length frequency samples (lfs). Smooth oreo sample catch weight, fishery catch, and sample catch as percentage of the fishery.

Year group	Year applied	No. of lfs	Catch sampled (t)	Fishery catch (t)	% fishery
1991–92 to 1995–96	1994–95	7	88	1 505	6
1998–99 to 1999–2000	1998–99	30	246	1 121	22
2000–2001 to 2002–03	2001–02	25	398	2 261	18
2003–04 to 2004–05	2004–05	29	261	2 280	11
2005–06	2005–06	32	379	1 121	34
2006–07 to 2007–08	2006–07	17	168	494	34

Relative abundance estimates from CPUE analyses

The small early Soviet fishery had too few data for a standardised CPUE analysis. The standardised CPUE analysis was, therefore, from the New Zealand vessel fishery and only included data from those vessels that had fished at least three years. A single vessel put in significant continuous effort from 1995 to 2007, with the effort of the rest of the vessels confined to mainly either 1995–2000 (early) or 2001–2007 (late). Because of this, in addition to the single standardised CPUE covering the entire time period, two separate standardised CPUE indices were calculated for the early and late periods. The final indices are shown in Tables 11 and 12.

4.4.2 Biomass estimates

In all preliminary model runs the length-frequency data series were not well fitted and gave a strong but contrasting biomass signal relative to the CPUE indices. Therefore, for final model runs, the length frequency data were down-weighted by using just the 1999 length frequency data.

The base case model used early and late period CPUE indices and the 1999 length frequency data. Current mature biomass was estimated to be 33% of a virgin biomass of 17 400 t (Figure 7).

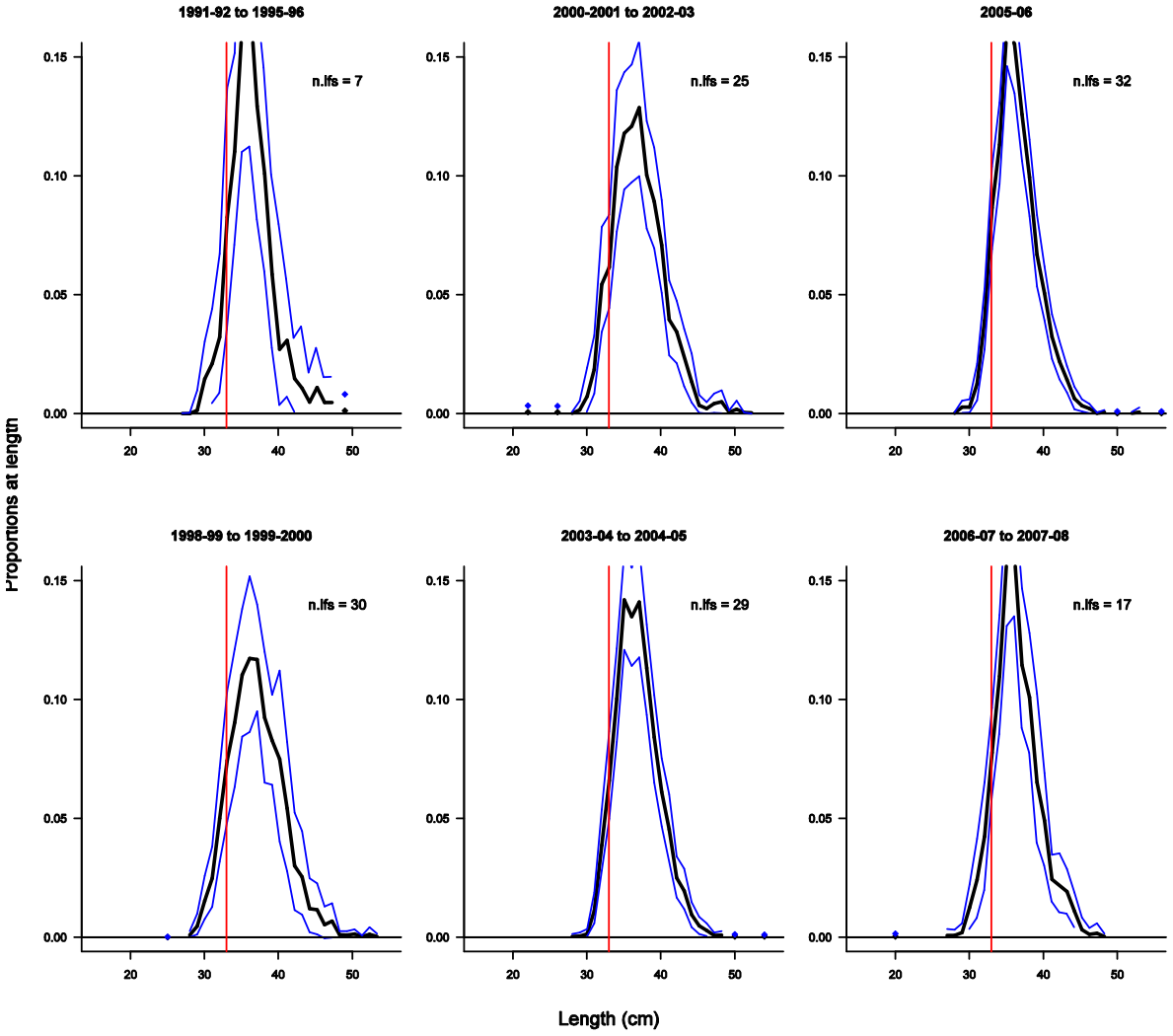


Figure 6: Length frequency distribution plots for core data only (thick lines) with 95% confidence interval (thin lines).

Table 11: Early and late period CPUE combined index estimates by fishing year, with bootstrap CV estimates.

Early period	Kg/tow	CV	Late period	Kg/tow	CV
1995–96	3 551	0.423	2000–01	850	0.487
1996–97	3 322	0.496	2001–02	2 976	0.274
1997–98	2 306	0.980	2002–03	1 489	0.243
1998–99	781	0.391	2003–04	1 727	0.260
1999–2000	1 536	0.306	2004–05	1 604	0.227
			2005–06	1 386	0.310
			2006–07	966	0.232

Table 12: Single period CPUE combined index estimates by fishing year, and bootstrap CV estimates.

Fishing year	Kg/tow	CV
1995–96	7 472	0.286
1996–97	4 453	0.735
1997–98	3 366	1.264
1998–99	1 444	0.406
1999–2000	2 835	0.286
2000–01	2 817	0.436
2001–02	632	0.680
2002–03	1 973	0.663
2003–04	1 296	0.615
2004–05	1 284	0.445
2005–06	1 289	0.563
2006–07	1 056	1.200

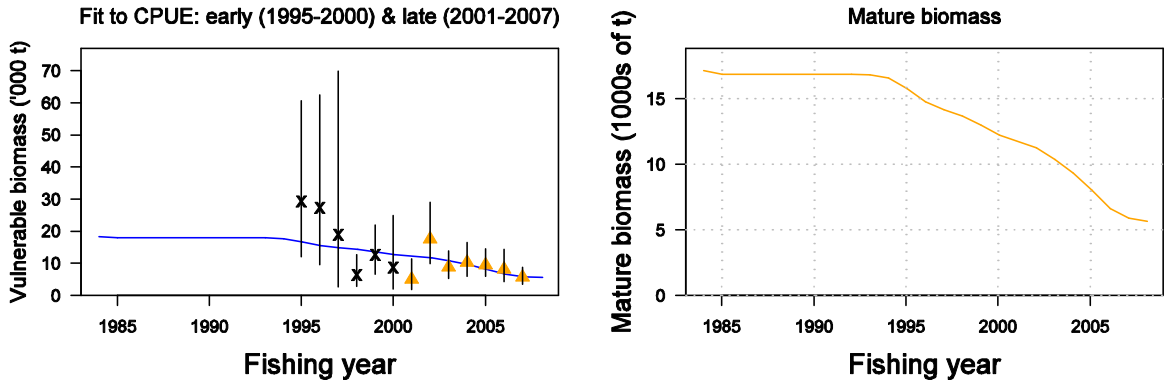


Figure 7: Model run showing the MPD fit to the CPUE data (vertical lines are the 95% confidence intervals for the indices) and the trajectory of mature biomass.

Two sensitivity model runs were carried out with the 1999 length frequency data dropped from the model but retaining the fishery selectivity estimated using the length data. The first model run used the early and late period CPUE indices and current biomass was estimated to be 39% of a virgin biomass of 19 300 t. The second model run used the single CPUE series covering the same period and current biomass was estimated to be 17% of a virgin biomass of 13 900 t. No MCMC runs were carried out with the base case model because the sensitivity runs showed that the assessment was quite different if the CPUE analysis was not split into two series.

Biomass estimates are uncertain because of the reliance on commercial CPUE data, the use of biological parameter estimates from other oreo stocks, and because of contrasting biomass signals from using either a single, or split, CPUE indices.

4.4.3 Projections

No projections were made because of the uncertainty in the assessment.

4.5 Pukaki Rise black oreo stock (part of OEO 6)

A second assessment for this fishery was attempted in 2013, applying only to the assessment area as defined in Figure 8. The first assessment for this fishery was in 2009 (Doonan et al 2010). This is currently the largest black oreo fishery in the New Zealand EEZ with both current (2011–12) and mean (1994–95 to 2011–12) annual catches of 1900 t, but with annual catches of 2800–3400 t between 2005–06 and 2009–10. There was an early Soviet and Korean fishery (1980–81 to 1984–85) with mean annual catches of about 1700 t. Fishery-independent abundance estimates were not available, so a series of relative abundance indices, based on an analysis of post-GPS standardised CPUE, was developed. Length frequency data collected by Ministry (SOP) and industry (ORMC) observers were included in the model. The assessment used biological parameter values estimated for Chatham Rise and Puysegur Bank black oreo because no biological data from Pukaki Rise are available. As stated above, the Pukaki Rise smooth oreo CPUE was thought to be unreliable until further investigations are conducted. Since the black oreo fishery is in the same area, the Working Group determined that the black oreo CPUE analysis also could not be accepted as an index of abundance of black oreo in the Pukaki Rise (OEO 6) assessment area, and as a result the assessment was rejected. Therefore, only catch history, length frequency distributions, and unstandardised catch and effort data are reported here.

4.5.1 Estimates of fishery parameters and abundance

Catch history

A catch history for black oreo was derived (Table 13) using declared catches of OEO from OEO 6 (table 2 in the Fishery Summary section of the Introduction – Oreos chapter) and tow-by-tow records of catch from the assessment area (Figure 8). The catch history used in the assessment is given in Table 13.

Table 13: Catch history (t) of black oreo from the Pukaki Rise fishery assessment area.

Fishing year	Catch	Fishing year	Catch	Fishing year	Catch
1978–79	17	1990–91	15	2002–03	1 701
1979–80	5	1991–92	27	2003–04	1 530
1980–81	283	1992–93	27	2004–05	1 588
1981–82	4 180	1993–94	10	2005–06	2 811
1982–83	1 084	1994–95	242	2006–07	3 434
1983–84	1 150	1995–96	1 352	2007–08	3 346
1984–85	1 704	1996–97	2 413	2008–09	2 818
1985–86	46	1997–98	2 244	2009–10	3 093
1986–87	0	1998–99	1 181	2010–11	1 641
1987–88	0	1999–00	1 061	2011–12	1 671
1988–89	0	2000–01	1 158		
1989–90	0	2001–02	988		

Length data

Black oreo length frequency data collected by SOP and ORMC observers are available for 1996–97 to 2011–12 (Table 14). An analysis indicated that there was a trend in fish size across years (with smaller mean lengths in more recent years) and with depth (deeper fish being larger). The length data were considered to be representative of the fishery in terms of the spatial, depth, and temporal coverage for those years that had adequate data. The length data were stratified into two depth bins: shallow (less than 900 m) and deep (greater than 900 m). Length data from adjacent years were grouped because of the low number of samples in some years (Figure 9). There is no trend in mean length over the first six year groups, but fish sizes appear to be generally smaller in the later year groups, with the mode of the distributions shifting to the left between 2005–06 and 2007–08.

Table 14: Summary of length frequency data for black oreo available from the assessment area. The table shows the number of tows sampled by year, the sample source, and the year group.

		Number of tows sampled		
Fishing year	Year group	SOP	ORMC	All
1996–97	97–98	7	0	7
1997–98	97–98	25	0	25
1998–99	99–00	7	44	51
1999–00	99–00	6	0	6
2000–01	01–02	8	18	26
2001–02	01–02	2	8	10
2002–03	03–05	7	2	9
2003–04	03–05	18	0	18
2004–05	03–05	21	0	21
2005–06	06	21	42	63
2006–07	07	154	11	165
2007–08	08	31	9	40
2008–09	08	61	9	70
2009–10	09	46	0	46
2010–11	10	57	0	57
2011–12	11–12	13	0	13
Total		477	134	611

Catch and effort data

The fishery taking Pukaki Rise black oreo is divided into two distinct periods: a pre-GPS period 1980–81 to 1984–85, when much of the catch was taken by Soviet and Korean vessels, and a post-GPS period, 1995–96 to 2011–12 when most of the catch was taken by New Zealand vessels. The intervening period was characterised by low catches and the introduction of GPS technology in the fleet. Standardisation of CPUE for the pre-GPS period was attempted but rejected due to poor linkage of vessels across years and the shifting of fishing effort between areas. For the post-GPS period, the Working Group rejected CPUE as an index of abundance because of the variability in recorded target species over time and space in the overlapping Pukaki fisheries for black oreo, smooth oreo, and orange roughy. The Working Group believed that recording of target species in these fisheries was likely to have been inconsistent between vessels and skippers over time and that the practice of separately examining these fisheries according to recorded target species was inappropriate. Unstandardised catch and effort data for defined core vessels are presented in Table 15.

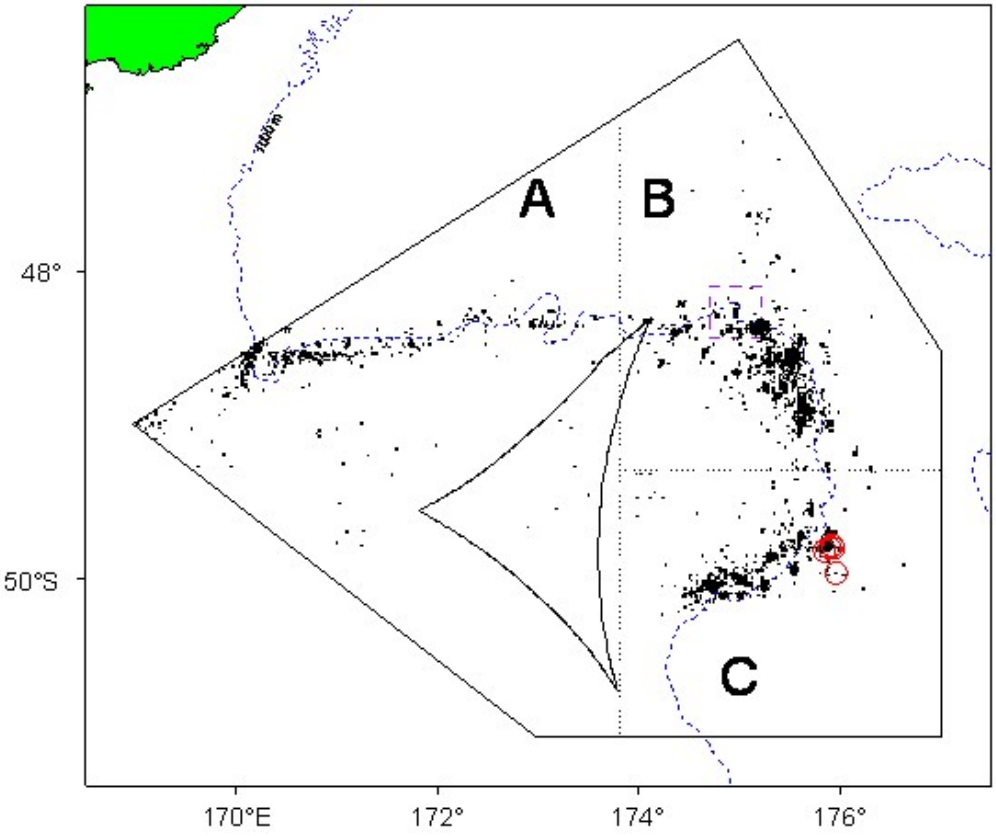


Figure 8: The Pukaki Rise fishery black oreo assessment area (polygon) abutting the boundary of OEO 6/OEO 1 in the north-west. The dots show tow positions where black oreo catch was reported between 1980–81 and 2011–12. A, B, and C are the three areas defined in the standardised CPUE analysis.

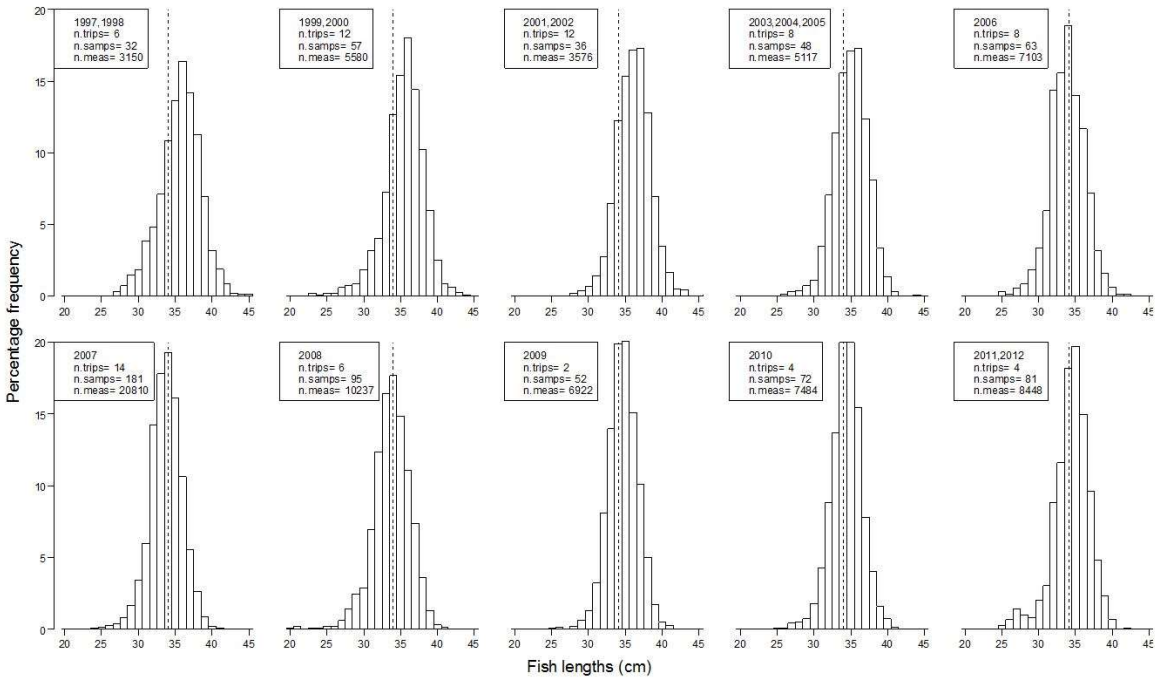


Figure 9: Observer length frequencies for Pukaki Rise black oreo, stratified by depth (see text), and grouped by years (in the legends 1997=1996–97, etc.). The vertical dashed lines indicate the approximate overall mean length as an aid to comparing the distributions.

Table 15: Catch and effort data for vessels fishing in the eastern areas (B and C in Figure 8) with a minimum of 15 successful tows for black oreo in at least three years from 1995–96 to 2011–12.

Fishing year	No. of tows	CPUE	CV	Fishing year	No. of tows	CPUE	CV
1995–96	63	1.94	0.09	2004–05	309	0.73	0.13
1996–97	55	1.44	0.13	2005–06	481	0.88	0.09
1997–98	219	1.53	0.07	2006–07	650	0.80	0.09
1998–99	235	0.98	0.11	2007–08	795	0.62	0.12
1999–00	252	0.82	0.12	2008–09	734	0.61	0.12
2000–01	199	1.11	0.10	2009–10	979	0.33	0.21
2001–02	175	1.07	0.11	2010–11	450	0.51	0.16
2002–03	320	0.91	0.10	2011–12	430	0.72	0.12
2003–04	343	0.97	0.09				

No projections were made because the assessment was not accepted by the Working Group.

4.5.2 Biomass estimates
No biomass estimates are reported.

4.5.3 Yield estimates and projections
No yield estimates were made.

4.6 Other oreo fisheries in OEO 1 and OEO 6

4.6.1 Estimates of fishery parameters and abundance

Relative abundance estimates from trawl surveys
Two comparable trawl surveys were carried out in the Puysegur area of OEO 1 (TAN9208 and TAN9409). The 1994 oreo abundance estimates are markedly lower than the 1992 values (Table 16).

4.6.2 Biomass estimates
Estimates of virgin and current biomass are not yet available.

4.6.3 Yield estimates and projections
MCY cannot be estimated because of the lack of current biomass estimates for the other stocks.

CAY cannot be estimated because of the lack of current biomass estimates for the other stocks.

4.6.4 Other factors
Recent catch data from this fishery may be of poor quality because of area misreporting.

Table 16: OEO 1. Research survey abundance estimates (t) for oreos from the Puysegur and Snares areas. N is the number of stations. Estimates for smooth oreo were made based on a recruited length of 34 cm total length. Estimates for black oreo were made using knife-edge recruitment set at 27 cm total length.

Smooth oreo					
Puysegur area (strata 0110–0502)					
	Mean biomass	Lower bound	Upper bound	CV (%)	N
1992	1 397	736	2 058	23	82
1994	529	86	972	41	87
Snares area (strata 0801–0802)					
	Mean biomass	Lower bound	Upper bound	CV (%)	N
1992	2 433	0	5 316	59	8
1994	118	0	246	54	7
Black oreo					
Puysegur area (strata 0110–0502)					
	Mean biomass	Lower bound	Upper bound	CV (%)	N
1992	2 009	915	3 103	27	82
1994	618	0	1 247	50	87
Snares area (strata 0801–0802)					
	Mean biomass	Lower bound	Upper bound	CV (%)	N
1992	3 983	0	8 211	53	8
1994	1 564	0	3 566	64	7

5. STATUS OF THE STOCKS

Stock Structure Assumptions
Oreos in the OEO 1 and 6 FMAs are managed as a single stock but assessed as four separate stocks, separated by species and geography.

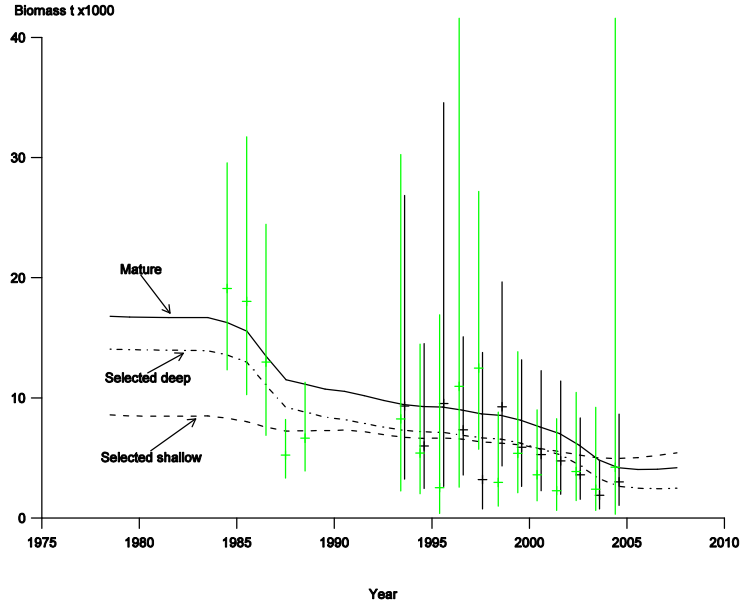
The Southland smooth oreo stock is based off the east coast of the South Island in OEO 1 but extends slightly into OEO 3. It does not include the Waitaki and Eastern canyon areas but is likely to have some level of mixing with other smooth oreo fishstocks. The Pukaki Rise smooth oreo stock comprises the major part of OEO 6 stocks and is centred on its namesake. Some mixing with other smooth oreo fishstocks is thought to occur. The Bounty Plateau smooth oreo stock is located across the Bounty Plateau. Some mixing is thought to occur with other smooth oreo fishstocks.

The Pukaki Rise black oreo stock is the main black oreo fishstock in OEO 6 and the largest black oreo fishstock in the New Zealand EEZ. It extends the entire length of the Pukaki Rise towards OEO 1. It is assessed separately to other fishstocks but managed as a part of OEO 6. Black oreo on the Pukaki Rise are thought to be non-mixing with other black oreo fishstocks.

- **OEO 1 and OEO 3A Southland (Smooth Oreo)**

Stock Status	
Year of Most Recent Assessment	2007
Assessment Runs Presented	One base case only
Reference Points	Target: 40% B_0 Soft Limit: 20% B_0 Hard Limit: 10% B_0 Overfishing threshold:
Status in relation to Target	B_{2007} was estimated at 27% B_0, Unlikely (< 40%) to be at or above the target.
Status in relation to Limits	B_{2007} was estimated to be Unlikely (< 40%) to be below the Soft Limit and Very Unlikely (< 10%) to be below the Hard Limit.
Status in relation to Overfishing	-

Historical Stock Status Trajectory and Current Status



Predicted biomass trajectories for the 2007 base case assessment— mature biomass and selected biomass for the shallow and deep fisheries. Also shown are the CPUE indices from the pre- and post-GPS analysis for the deep fishery (in green) and the post-GPS analyses for the shallow fishery (in black). CPUE indices are shown with ±2 s.e. confidence interval indicated by the vertical lines (the post-GPS CPUE data are slightly offset to avoid over plotting). The CPUE data were scaled by catchability coefficients to match the biomass scale.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Biomass has been declining at a steady rate since the late 1980s.
Recent Trend in Fishing Mortality or Proxy	Unknown
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis	
Stock Projections or Prognosis	None because of assessment uncertainty.
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Soft Limit: Unknown Hard Limit: Unknown
Probability of Current Catch or TACC causing Overfishing to continue or to commence	-

Assessment Methodology		
Assessment Type	Type 1 - Quantitative Stock Assessment	
Assessment Method	Age-structured CASAL model with Bayesian estimation of posterior distributions.	
Assessment Dates	Latest assessment: 2007	Next assessment: Unknown
Overall assessment quality rank	-	
Main data inputs (rank)	- Length-frequency data collected by SOP and ORMC observers - A second, earlier fishery based on Soviet vessels was included in the assessment using historical catch data. - Standardised CPUE indices were derived from the historical and modern datasets.	
Data not used (rank)	-	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	- Scarcity of observer length frequency data - Poor quality area catch data due to significant misreporting - Lack of fishery-independent abundance estimates creates reliance on commercial CPUE data.	

Qualifying Comments
-

Fishery Interactions
Both species of oreo are sometimes taken as bycatch in orange roughy target fisheries and in smaller numbers in hoki target fisheries. Target fisheries for oreos do exist, with main bycatch being orange roughy, rattails, and deepwater sharks and rays. Other bycatch species recorded include seabirds and deepwater corals. Oreo are caught using bottom trawl gear. Bottom trawling interacts with benthic habitats.

- **OEO 6 Pukaki Rise (Smooth Oreo)**

Stock Status	
Year of Most Recent Assessment	2006
Assessment Runs Presented	CASAL assessment based on CPUE
Reference Points	Target: 40% B_0 Soft Limit: 20% B_0 Hard Limit: 10% B_0 Overfishing threshold: $F_{40\% B0}$
Status in relation to Target	Unknown
Status in relation to Limits	Unknown
Status in relation to Overfishing	Unknown
Historical Stock Status Trajectory and Current Status -	

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Biomass is likely to have been declining since 1996.
Recent Trend in Fishing Intensity or Proxy	Unknown
Other Abundance Indices	CPUE has steadily declined.
Trends in Other Relevant Indicators or Variables	-
Projections and Prognosis	
Stock Projections or Prognosis	No projections were made due to the uncertainties in the assessment.
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Soft Limit: Unknown Hard Limit: Unknown
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown

Assessment Methodology and Evaluation		
Assessment Type	Type 1 – Quantitative Stock Assessment	
Assessment Method	CASAL assessment based on CPUE	
Assessment Dates	Latest assessment: 2006	Next assessment: Unknown
Overall assessment quality rank	3 – Low Quality	
Main data inputs (rank)	-	
Data not used (rank)	Commercial CPUE	3 – Low Quality: does not track stock biomass
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	- Lack of fishery-independent biomass estimates creates reliance on commercial CPUE data. - Lack of biological parameters specific to Smooth Oreo in the target area – data from Chatham Rise/Puysegur Bank had to be substituted instead.	

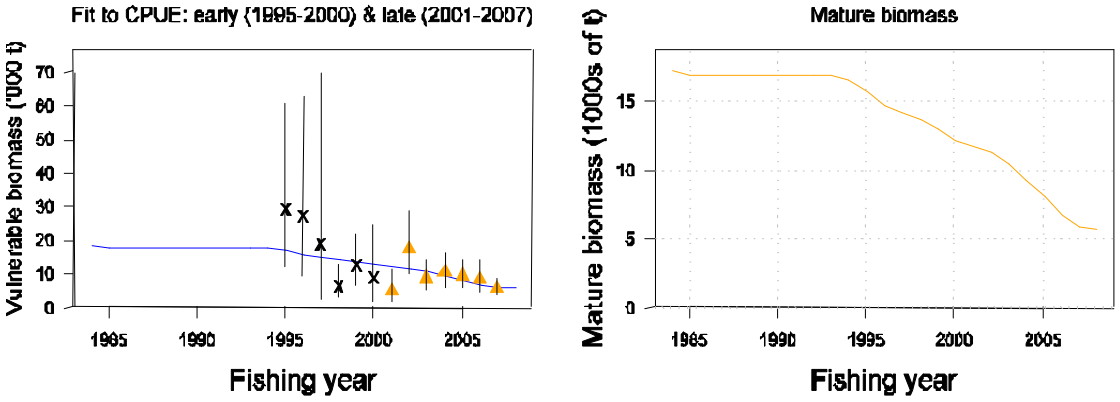
Qualifying Comments
Further investigations into CPUE are required.

Fishery Interactions
Both species of oreo are sometimes taken as bycatch in orange roughy target fisheries and in smaller numbers in hoki target fisheries. Target fisheries for oreos do exist, with main bycatch being orange roughy, rattails, and deepwater sharks. Low productivity bycatch species include deepwater sharks and rays. Protected species interactions occur with seabirds and deepwater corals.

- **OEO 6 Bounty Plateau (Smooth Oreo)**

Stock Status	
Year of Most Recent Assessment	2008
Assessment Runs Presented	A base case with two sensitivity runs
Reference Points	Target: 40% B_0 Soft Limit: 20% B_0 Hard Limit: 10% B_0
Status in relation to Targe	B_{2008} was estimated at 33% B_0; Unlikely (< 40%) to be at or above the target.
Status in relation to Limits	B_{2008} is Unlikely (< 40%) to be below the Soft Limit and Very Unlikely (< 10%) to be below the Hard Limit.
Status in relation to Overfishing	-

Historical Stock Status Trajectory and Current Status



Model run showing the MPD fit to the CPUE data (vertical lines are the 95% confidence intervals for the indices) and the trajectory of mature biomass.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Biomass is estimated to have been decreasing rapidly since 1995.
Recent Trend in Fishing Mortality or Proxy	Unknown
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis	
Stock Projections or Prognosis	No projections were made because of the uncertainty of the assessment.
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Soft Limit: Unknown Hard Limit: Unknown
Probability of Current Catch or TACC causing overfishing to continue or to commence	Unknown

Assessment Methodology and Evaluation		
Assessment Type	Type 1 - Quantitative Stock Assessment	
Assessment Method	Age-structured CASAL model with Bayesian estimation of posterior distributions	
Assessment Dates	Latest assessment: 2008	Next assessment: Unknown
Overall assessment quality rank		
Main data inputs (rank)	- Catch history - Abundance estimates derived from a standardised CPUE - Length data from SOP and ORMC observers	
Data not used (rank)	-	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	- Reliance on commercial CPUE data - To estimate biological parameters, data was used from different stocks (Puysegur Bank + Chatham Rise) to the target stock - Using a single CPUE index instead of split indices gives contrasting biomass signals	

Qualifying Comments
-

Fishery Interactions
Both species of oreo are sometimes taken as bycatch in orange roughy target fisheries and in smaller numbers in hoki target fisheries. Target fisheries for oreos do exist, with main bycatch being orange roughy, rattails, and deepwater sharks. Other bycatch species recorded include deepwater sharks and rays, seabirds, and deepwater corals. Oreo are caught using bottom trawl gear. Bottom trawling interacts with benthic habitats.

- **OEO 6 Pukaki Rise (Black Oreo)**

Stock Status	
Year of Most Recent Assessment	2009
Assessment Runs Presented	CASAL assessment based on CPUE
Reference Points	Target: 40% B_0 Soft Limit: 20% B_0 Hard Limit: 10% B_0 Overfishing threshold: $F_{40\% B0}$
Status in relation to Target	Unknown
Status in relation to Limits	Unknown
Status in relation to Overfishing	Unknown
Historical Stock Status Trajectory and Current Status	

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Biomass is likely to have been decreasing since the 1980s with a major decline starting about 1995.
Recent Trend in Fishing Intensity or Proxy	Unknown
Other Abundance Indices	CPUE declined, but has levelled out in the last four years.
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis		
Stock Projections or Prognosis	-	
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Soft Limit: Unknown Hard Limit: Unknown	
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown	
Assessment Methodology and Evaluation		
Assessment Type	Type 1 - Quantitative Stock Assessment	
Assessment Method	CASAL assessment based on CPUE	
Assessment Dates	Latest assessment: 2009	Next assessment: Unknown
Overall assessment quality rank	3 – Low Quality	
Main data inputs (rank)	-	
Data not used (rank)	Commercial CPUE	3 – Low Quality: does not track stock biomass
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	- Lack of fisheries-independent data causes reliance on commercial CPUE data - Lack of biological parameter estimates specific to black oreo in this assessment area	

Qualifying Comments
Further investigations into CPUE are needed.

Fishery Interactions
Both species of oreo are sometimes taken as bycatch in orange roughy target fisheries and in smaller numbers in hoki target fisheries. Target fisheries for oreos do exist, with main bycatch being orange roughy, rattails, and deepwater sharks. Low productivity bycatch species include deepwater sharks and rays. Protected species interactions occur with seabirds and deepwater corals. Oreo are caught using bottom trawl gear. Bottom trawling interacts with benthic habitats.

6. FOR FURTHER INFORMATION

Coburn, R P; Doonan, I J; McMillan, P J (2002) CPUE analyses for the Southland black oreo and smooth oreo fisheries, 1977–78 to 1999–2000. *New Zealand Fisheries Assessment Report 2002/3.* 28 p.

Coburn, R P; Doonan, I J; McMillan, P J (2002) CPUE analyses for the major black oreo and smooth oreo fisheries in OEO 6, 1980–81 to 1999–2000. *New Zealand Fisheries Assessment Report 2002/6.* 29 p.

Coburn, R P; Doonan, I J; McMillan, P J (2003) Stock assessment of smooth oreo in the Southland fishery (OEO 1 and 3A) for 2003. *New Zealand Fisheries Assessment Report 2003/62*. 32 p.

Coburn, R P; Doonan, I J; McMillan, P J (2008) A stock assessment of smooth oreo in Southland (part of OEO 1 & OEO 3A). *New Zealand Fisheries Assessment Report 2008/37*. 43 p.

Coburn, R P; McMillan, P J; Gilbert, D J (2007) Inputs for a stock assessment of smooth oreo, Pukaki Rise (part of OEO 6). *New Zealand Fisheries Assessment Report 2007/23*. 32 p

Doonan, I J; Anderson, O F; McMillan, P J (2010) Assessment of Pukaki (OEO 6) black oreo for 2008–09. *New Zealand Fisheries Assessment Report 2010/39*.

McKenzie, A (2007) Stock assessment for east Pukaki Rise smooth oreo (part of OEO 6). *New Zealand Fisheries Assessment Report 2007/34*. 27 p.

McMillan, P J; Coburn, R P; Hart, A C; Doonan, I J (2002) Descriptions of black oreo and smooth oreo fisheries in OEO 1, OEO 3A, OEO 4, and OEO 6 from 1977–78 to the 2000–01 fishing year. *New Zealand Fisheries Assessment Report 2002/40*. 54 p.